

Title: Impacts of the Convective Transport Algorithm on Atmospheric Composition and Ozone-Climate Feedbacks in GEOS-CCM

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Abstract

Convective transport is one of the dominant factors in determining the composition of the troposphere. It is the main mechanism for lofting constituents from near-surface source regions to the middle and upper troposphere, where they can subsequently be advected over large distances. Gases reaching the upper troposphere can also be injected through the tropopause and play a subsequent role in the lower stratospheric ozone balance. Convection codes in climate models remain a great source of uncertainty for both the energy balance of the general circulation and the transport of constituents. This study uses the Goddard Earth Observing System Chemistry-Climate Model (GEOS CCM) to perform a controlled experiment that isolates the impact of convective transport of constituents from the direct changes on the atmospheric energy balance. Two multi-year simulations are conducted. In the first, the thermodynamic variable, moisture, and all trace gases are transported using the multi-plume “Relaxed-Arakawa-Schubert” (RAS) convective parameterization. In the second simulation, RAS impacts the thermodynamic energy and moisture in this standard manner, but all other constituents are transported differently. The accumulated convective mass fluxes (including entrainment and detrainment) computed at each time step of the GCM are used with a diffusive (bulk) algorithm for the vertical transport, which above all is less efficient at transporting constituents from the lower to the upper troposphere. Initial results show the expected differences in vertical structure of trace gases such as carbon monoxide, but also show differences in lower stratospheric ozone, in a region where it can potentially impact the climate state of the model. This work will investigate in more detail the impact of convective transport changes by comparing the two simulations over many years (1996-2010), focusing on comparisons with observed constituent distributions and similarities and differences of patterns of inter-annual variability caused by the convective transport algorithm. In particular, the impact on lower stratospheric composition will be isolated and the subsequent feedbacks of ozone on the climate forcing and tropopause structure will be assessed.